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SOURCE Doklady Akademii Nauk SSSR, Novaya Seriya, Vol LXXIV, No 4, 1950, pp 703-706.

TEMPERATURE OF THE UPPER LAYERS OF THE ATMOSPHERE FROM THE BRIGHTNESS OF THE TWILIGHT ARC

N. M. Shtaude
Submitted 10 Jul 1950
by Acad S. I. Vavilov

/Figures are appended./

Determinations of temperature made by the twilight method up to this time have been based on determinations of zenith brightness, as far as is known to the author. This brightness is in some measure exaggerated by the effect of scattering of second and higher orders, and as a result the temperatures found may require considerable corrections.

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It would be simple to evaluate these corrections by determining the temperature using the twilight method independently of both zenith observations and observations on a certain point of the twilight arc, preferably in the sun's prime vertical. This idea is credited to Academician V. G. Fesenkov.

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Starting from these considerations, the author first determined the position of that point in the sun's prime vertical where the influence of secondary scattering was a minimum.

Using a method similar to that in a preceding work (N. Shtaude, DAN, Vol LIX, No 7, 1948, [redacted] the author calculated the influence of second-order scattering on the brightness of twilights for a number of points in the sun's prime vertical for a dipping of 8° beneath the horizon. The transparency coefficient was taken to be equal to 0.835, which corresponds to the green region of the spectrum. The structure of the upper layers was assumed to be that which is obtained from twilight observations.

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An approximate formula was used for the brightness of secondary-scattered light in the calculations; it describes the effect quite well, since it was derived by comparison of the author's results for the zenith with the values obtained by F. F. Yudalevich by direct integration (DAN, Vol LIX, No 7, 1948, [redacted] sanitized 50X1-HUM

The results of the calculations are shown in Figure 1, in which the dipping angle A beneath the western horizon (for evening twilights) is placed along the abscissa and the theoretical brightness of the sky in stellar magnitudes from a degree squared along the ordinate; the broken curve gives the behavior of the brightness m_I for primarily scattered light, while the solid curve m_{I+II} gives the same with consideration for second-order scattering.

The graph shows that the influence of secondary scattering is a minimum close to the maximum of the curve m_I; with a further increase of A, it first increases slowly and then more and more rapidly, tending to infinity in the region of the geometrical shadow of the earth.

It is natural to suppose that we should obtain a similar picture for rays of another spectral region, so that for sky observations the effect of second-order scattering could be disregarded at the peak of the curve m_I.

Thus, instead of prolonged calculations of secondary scattering with respect to various directions in each separate case, it is sufficient to construct a graph of the theoretical distribution of primary brightness in the sun's prime vertical, and this problem is very easily solved (L. Shtaude, Iz Ak Nauk Kazakh SSR, 32, 22, 97, 1946; N. Shtaude, Iz Ak Nauk USSR, Ser Geograf i Geofiz, Vol XIII, No 4, 1949 [redacted] 50X1-HUM

Figure 2 gives the deformation of the curve m_I with a change of the transparency coefficient. The numbers 1, 2, and 3 designate graphs for violet, green, and red rays for transparency coefficients of 0.515, 0.835, and 0.990, respectively. This data is also for an 8° dipping angle beneath the horizon. The dependence upon the latter was investigated for green rays for dipping angles from 2 to 10°, and the position of the brightness maximum did not change substantially.

Thus, it is easy to select for each spectral region a point of the sky at which the influence of second-order scattering is very close to zero throughout the entire twilight effect.

In February and March 1948 at Alma-Ata, the author made simultaneous twilight observations with two tube photometers for three evenings. One photometer was lined up with the zenith, while the other was at an angle of 20° with the horizontal, approximately in the sun's prime vertical. The photographs were made without a filter on ordinary plates. The results are shown in Figure 3.

Figure 4 refers to the control photograph, when both photometers were lined up with the zenith. In all three cases, the "zenith" temperatures were very close to the "red glow" temperatures at heights below 70 kilometers and considerably exceeded the latter at heights around 100 kilometers and above.

On all graphs, the solid circles denote the more reliable observations, while the light circles indicate data with less weight. The solid line refers to photometer I and the broken line to photometer II. The results were not changed by interchanging the positions of the photometers.

The equipment used was not suited to this type of observation, and thus the results obtained require confirmation with the aid of more accurate instruments which are more fitted to this work (photocells fitted with light filters in an azimuth mounting suitably graduated).

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We note that despite the crude equipment used, the temperatures found are closer to the standards adopted at present than those obtained by the twilight method from zenith observations.

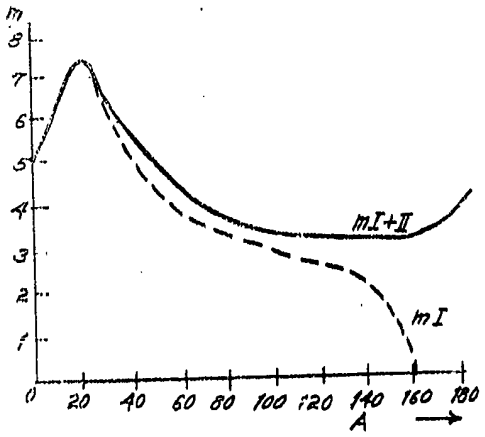

Figure 1

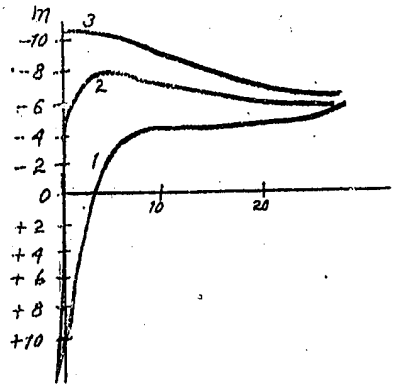

Figure 2

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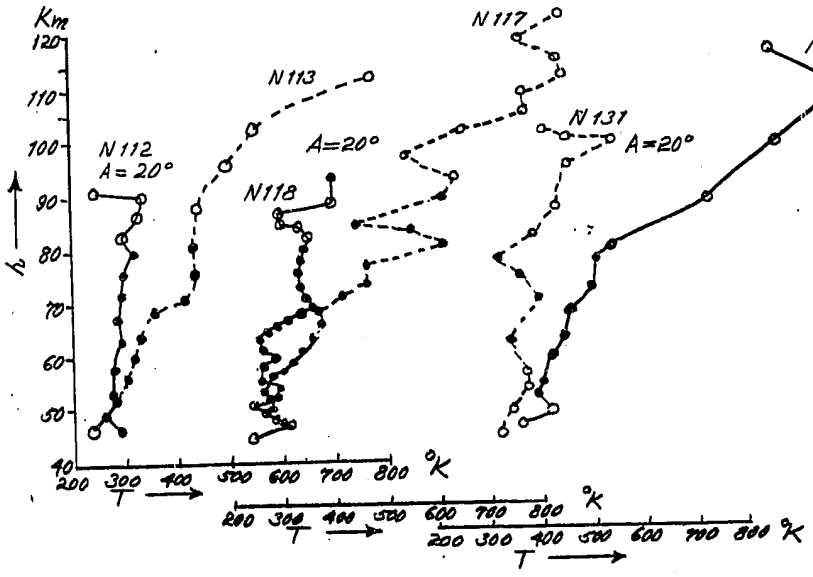

Figure 3

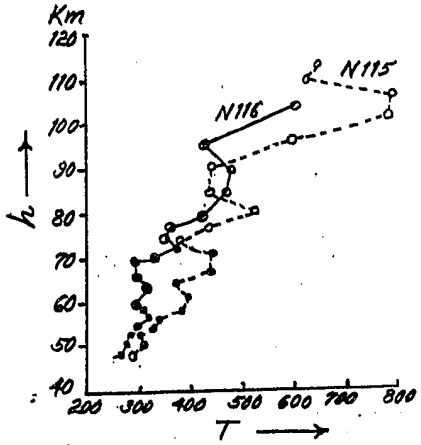

Figure 4

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